PRACTICE ABSTRACT

Optical sensors for adjusting N fertilization

Problem

Application of nitrogen fertilizer in excess of crop requirements is a common practice in agriculture, to ensure maximum production. However, this usually incurs an additional cost to farmers and increases environmental risk due to nitrogen losses.

Solution

Optical sensors can detect the nutritional status of crops before serious nutrient deficiencies become a growth limitation and be used to adjust N fertilizer rate and timing to meet crop requirements. This method has been developed for several crops (e.g., wheat, maize and potato) and under various environmental conditions. Optical sensors are available to buy or rent for carrying out measurements (Figure 1), although this is an additional cost for the farmer, in the long-term, they will benefit financially for saving fertilizer costs. To mitigate varietal and environmental effects, it is advisable to have a reference band in the field with the recommended N rate. This will require an additional fertilizer application to apply the recommended rate.

Benefits

- Reduction of N fertilizer application with respect to the recommended rate with minimal risk of yield decrease.
- Reduced nitrogen fertilizer costs, resulting in improved profit margins.
- Improved timing of fertilizer application to meet crop requirements.
- Improved nitrogen use efficiency, as the optimum fertilizer rate (i.e., maximum benefit) is ensured versus the maximum yield.
- Nitrogen surplus is reduced, also reducing the risk of N losses that are harmful to the environment

Applicability box

Theme

Nutrient use, reduced fertilizer use, bread wheat, durum wheat and potato.

Agronomic conditions

Sensors have been used in multiple environmental conditions and various crops, and can be used anywhere. In the SolACE project the sensors were tested to adjust N fertilizer rate on winter wheat under water-limited and non-limited conditions.

Application time

Prior to fertilizer application; before either the first, the second or the third.

Required time

Little additional work required, only the time required to establish a reference band and take periodic measurements.

Period of impact

At time of fertilizer application and harvest in the actual crop.

Equipment

Optical sensor, either leaf clip or proximal (handheld contact less and or tractor-mounted).

Best in

Crops with high nitrogen demand (e.g. wheat, maize, potato) and in which split fertilizer applications are applied.

Figure 1: Several hand held optical sensors to measure crop nutritional status of the crop. The image on the right shows a more sophisticated field spectroradiometer used to compare the measurementof the commercial equipments.

Practice abstract

Practical recommendation

- **Planning fertilizer application**. The first step is to determine the optimum amount of N fertilizer for a specific crop, expected yield based on regional recommendations and in-field measurements if available (i.e. soil mineral N content before fertilization). Then, fertilization is split in two or three applications to supply N to the crop as close as possible to the time to meet crop demand.
- **Soil analysis**. The first fertilizer application for winter wheat is usually broadcasted at the end of tilling to ensure N availability. This application can be tailored based on the amount of mineral N present in the soil that can be measured by a soil test at tilling. If the amount of N in the first 0.40m of the soil is larger than 40 kg N/ha, this first application is not necessary.
- **Using an optical sensor.** The second application usually occurs at wheat stem elongation when the crop starts to accumulate biomass. This can be tailored with optical sensors by distinguishing responsive from non-responsive sites. The recommendation is to include a reference band in the field that is fertilized with the recommendation rate. The sites in which the optical sensor reading is above 95% of the reading in the reference band are not likely to respond to the N fertilizer application; on the other hand, sites in which the reading is below 95% of the reference band are likely to respond to additional N fertilization. If a third N fertilizer application is applied at flowering to enhance grain protein content, a similar rule can be followed: Only sites that have optical sensor readings below 95% of the reference band are likely to respond to additional N fertilization.

Tools

Handheld optical sensors are economical and easy to use. They can be leaf clip type sensors or proximal sensors (contactless). Usually, they provide an estimate of the chlorophyll activity of the crop area measured by an approximation based on optical characteristics (i.e. transmittance or reflectance). The numbers of measurements depend on the variability of the crop and the capacity of the farmer to apply different N fertilizer rates. Tractor-mounted sensors linked to variable rate fertilizer spreaders (Figure 2) are increasingly used and will be a common practice soon. They rely on the same principles but for the moment, require a larger investment and technical expertise from the user.

Figure 2. Sensors mounted on a variable fertilizer rate spreader.

Further information

- Arregui et al. 2006. Evaluation of chlorophyll meters as tools for N fertilization in winter wheat under humid Mediterranean conditions. European Journal of Agronomy. 24: 140-148. https://doi.org/10.1016/j.eja.2005.05.005
- UK Cooperative extension service: Use of chlorophyll meters in wheat
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About this practice abstract and SolACE

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SolACE: The project is running from May 2017 to April 2022**.** The goal of SolACE (Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use) is to help European agriculture face major challenges, notably increased rainfall variability and reduced use of N and P fertilizers

Project website: www.solace-eu.net

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